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# GEOLOGY OF
# THE SOUTHERN PART OF THE QUAIL QUADRANGLE, CALIFORNIA

By CHARLES W. JENNINGS

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# GEOLOGY OF THE SOUTHERN PART OF THE QUAIL QUADRANGLE, CALIFORNIA *

By Charles W. Jennings **

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## ABSTRACT

In the southern part of the Quail quadrangle, which lies in the ansverse Ranges of California, is a thick section of non-marine iocene sedimentary rocks against which are faulted the crystalline sement rocks of probable Jurassic age. The sedimentary rocks, ich belong to the Hungry Valley formation and Peace Valley ds, are subdivided into eight members ranging from coarse con- omerate to fine-grained siltstone.

Structurally the Quail area is part of the northeastern flank of e Ridge Basin syncline which is complicated by numerous north- st-trending folds and faults. The Liebre fault—a prominent rust which brings the crystalline rocks of the basement complex ainst the Pliocene sediments—bounds Ridge Basin on the north- st.

The gentle rolling crest of Liebre Mountain is a prominent geo- orphic feature of the area and is believed to represent an older osional surface. Contiguous to this erosional surface, but at a newhat lower elevation, lie the remnants of Quaternary terrace d fanglomerate deposits.

Although the crystalline rocks of Liebre Mountain have been ospected for many years, no mineral deposits of economic value ve been discovered. However, since the recent discovery of a new field in the Castaic Hills to the south, the geologic study of the dge Basin area has attained additional significance.

## INTRODUCTION

*Purpose of the Investigation.* No published material is available on the geology of the southern portion of the Quail quadrangle, an area situated in a geologically important structural position in the northeastern part of the Ridge Basin (see pl. 1). The purpose of the investigation, therefore, was to make an areal study of the general geology of the region, and to prepare a geologic map.

*Location and Accessibility.* The Quail quadrangle is in the Transverse Ranges of California, approximately 70 miles northwest of Los Angeles (fig. 1). U. S. Highway 99 is the closest arterial highway to this region. The eastern margin of the area is traversed by the "Old Ridge Route," formerly Highway 99, while the central part of the area is accessible by a dirt road maintained by the Southern California Edison Company.

The southern part of the area lies in the Angeles National Forest, and an improved Forest Service camp ground is on the "Old Ridge Route" approximately 2.5 miles south of Sandsberg. The northern portion of the area is bounded by Liebre Mountain. Its undulating summit is used largely as farm land with wheat being the principal crop. A small part of the area is also used for cattle grazing.

*Climate and Vegetation.* The climate is typically semi-arid; most of the rain falls from November through April. The average annual precipitation amounts to about 13 inches rain and 23 inches snow. During much of the year a strong wind from the north sweeps over the region and is concentrated particularly at two low spots in the range, Sandberg and Tumble Inn camp ground.

The vegetation is largely chaparral, consisting principally of chamise, manzanita, sumac, buckbrush, and scrub oak. Creek bottoms and springs support a dense growth of sycamore, cottonwood, willow, and oak. On the higher slopes are groves of yellow pine, big-cone spruce, California live oak, and juniper. Steep slopes support a sage association of black sage, yucca, and buckwheat.

*Physical Features.* Elevations range from 3000 feet in Liebre Gulch to over 5000 feet on Liebre Mountain. The top of Liebre Mountain is remarkably flat to gently rolling and is covered by a thick mantle of decomposed igneous rock which provides a fertile soil conducive to farming. In the southern part of the area the sedimentary rocks are fine-grained and unconsolidated and are highly susceptible to slumping.

The greater part of the area is drained by intermittent streams in Liebre Gulch and the West Fork Liebre Gulch which converge south of the area at Piru Creek. The drainage is then southward to the Santa Clara River valley, and thence westward for 35 miles to the sea. All the creeks are dry during summer, but small springs, sparsely distributed, provide water for ranches. Some of the springs occur along faults and hence their location may aid in geologic mapping.

*Previous Work.* No detailed geologic maps of this area have been published. The southern part of the area is

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n partial fulfillment of the requirements for the degree, Master of Arts, University of California at Los Angeles.

Junior Mining Geologist, California Division of Mines. Manuscript submitted for publication August 1952.

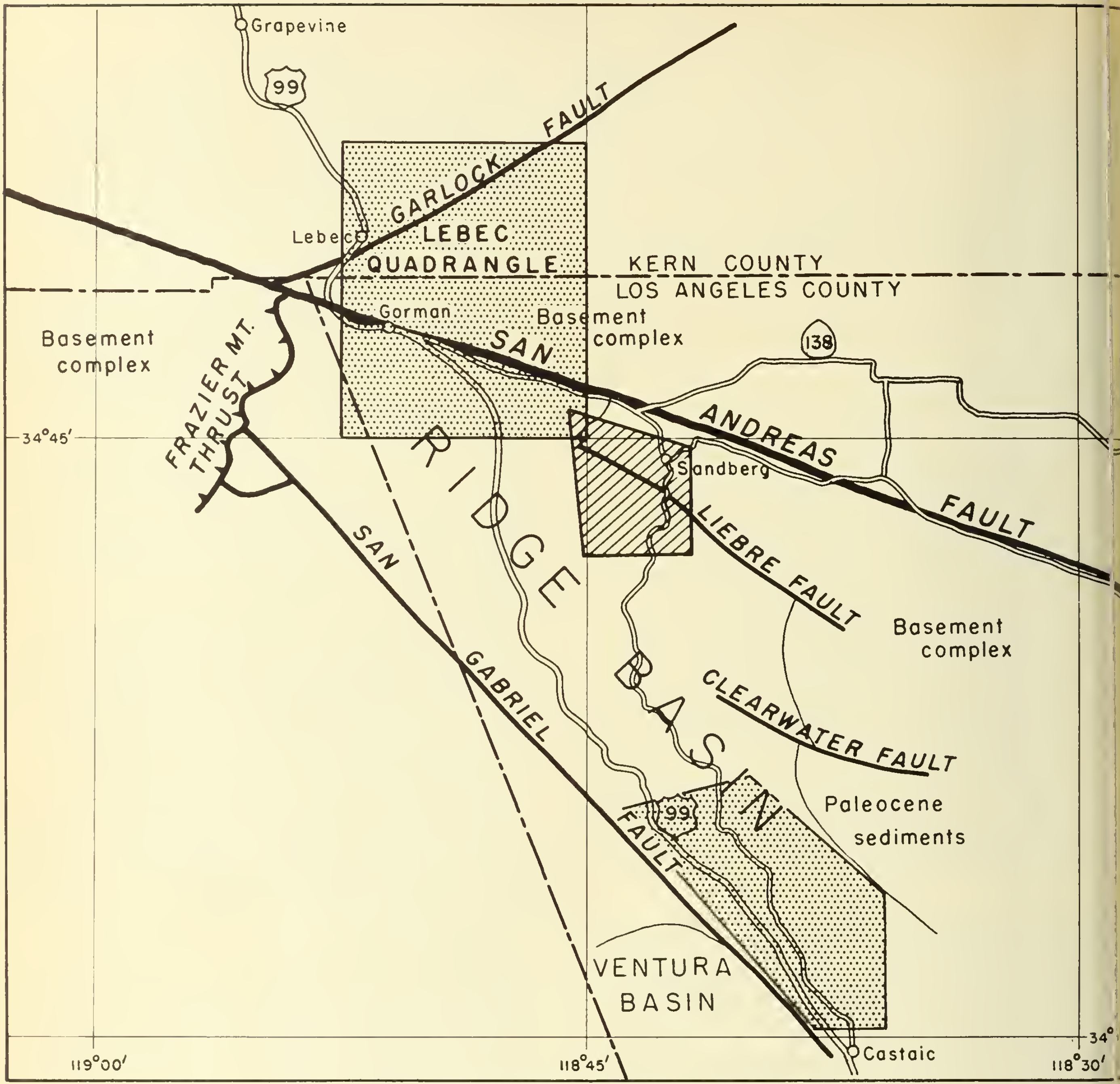


FIGURE 1. Index map showing area mapped in Ridge Basin.

riefly referred to in the work by J. E. Eaton (1939) hich deals mainly with the geologic history of Ridge asin and includes a reconnaissance map of a much larger rritory. J. C. Crowell (1950, 1952) has published papers n the Hungry Valley and Peace Valley areas a few miles o the west and northwest, and the region adjacent to the uail area on the north and east is described in papers by . H. Wiese (1950) and S. F. Fine (1947). Part of the egion to the south is described in an unpublished thesis y V. M. Smith (1951) and the geology along U. S. High-ay 99, a mile west of the Quail area, is described in a aper by W. Loel (1947) in which he includes a gen-ralized map and geologic section taken along the route of he highway.

*Field Work and Acknowledgments.* The field work or this report was done intermittently from February to ugust, 1951. Field mapping was done on United States orest Service aerial photographs flown in 1942 with a cale of 1:15,840 or 4 inches to the mile. The data were fterwards transferred to the Quail quadrangle topo-raphic map issued by the United States Geological Sur-ey in 1938 which had been enlarged to the same scale as he aerial photographs. Approximately 15 square miles ere mapped and studied in detail.

The writer wishes to acknowledge his appreciation to . C. Crowell and D. I. Axelrod who suggested the prob-em and who supervised the preparation of this report and o W. P. Popenoe for aid in identification of fossils.

The hospitality and interest extended by J. McCue and amily during the days the writer spent in the field are specially appreciated. Other residents in the area whose riendliness and cooperation were genuinely helpful in-lude Mr. and Mrs. D. A. Davidson and Mr. J. Rimmer.

## DESCRIPTIVE GEOLOGY

The southwest part of the Quail quadrangle is charac-erized by a thick section of nonmarine Tertiary sedimen-ary rocks. In the northeastern part of the area the Liebre ault brings crystalline rocks of the Jurassic (?) basement omplex over the Pliocene sediments. One small exposure f andesite is within the basement rocks near the Liebre ault contact. Close to Liebre Mountain the sediments are oarse conglomeratic sandstones, but southwestward they rade into finer-grained clastics. Hilltops are commonly overed with loose terrace deposits while fanglomerates est locally on crystalline basement rocks or lie uncon-ormably on the Tertiary sediments.

### Basement Complex (Jurassic ?)

The north and northeastern part of the area is bounded y Liebre Mountain which is composed largely of crystal-ine rocks. These rocks originally formed the highland rom which the Pliocene sediments were derived, and later served as a buttress against which the weaker clastics ere folded and crushed.

The composition of these rocks is highly variable, rang-ng from granite to gabbro; the most common type is uartz monzonite. In general, the plutonic rocks cannot e subdivided into separate facies because their scattered ccurrence and highly sheared nature prohibits their sep-ration into even vague units. Therefore, most of the crys-alline rocks have been grouped together and shown on he map as simply "basement complex." In the descriptive discussion of the plutonic rocks, however, the various rock types are described in detail. In one locality a black hornblende gabbro occurs as a distinctive unit and at another place bright orange monzonite can be readily distinguished from the rest of the basement complex. The lithologic boundaries of these two rock outcrops have been shown on the geologic map.

The age of the crystalline rocks of Liebre Mountain is unknown as they do not penetrate fossiliferous strata. However, because they closely resemble rock types in the Sierra Nevada batholith, which is known to have been emplaced in the late Jurassic or early Cretaceous, these rocks are inferred to be of the same age.

*Quartz Monzonite.* The greater portion of the Liebre Mountain massif is composed of quartz monzonite. One mile to the west of the area, similar rocks crop out along Highway 99 and probably represent the crystalline basement beneath the northern Ridge Basin sediments (Crowell, 1950, p. 1630). The quartz monzonite is deeply weathered owing to its susceptibility to decomposition and because of an irregular system of joints and fractures. Good exposures are scarce and the usual topographic expression is gentle undulating hills with a deep soil cover.

Hand specimens are gray or pink and are generally medium-grained with a hypautomorphic granular texture. The rock contains approximately equal amounts of plagioclase and potash feldspar and generally the pink potash feldspar is in coarse crystals, giving the rock a porphyritic texture. The only other prominent minerals visible in hand specimens are dark gray quartz and black biotite.

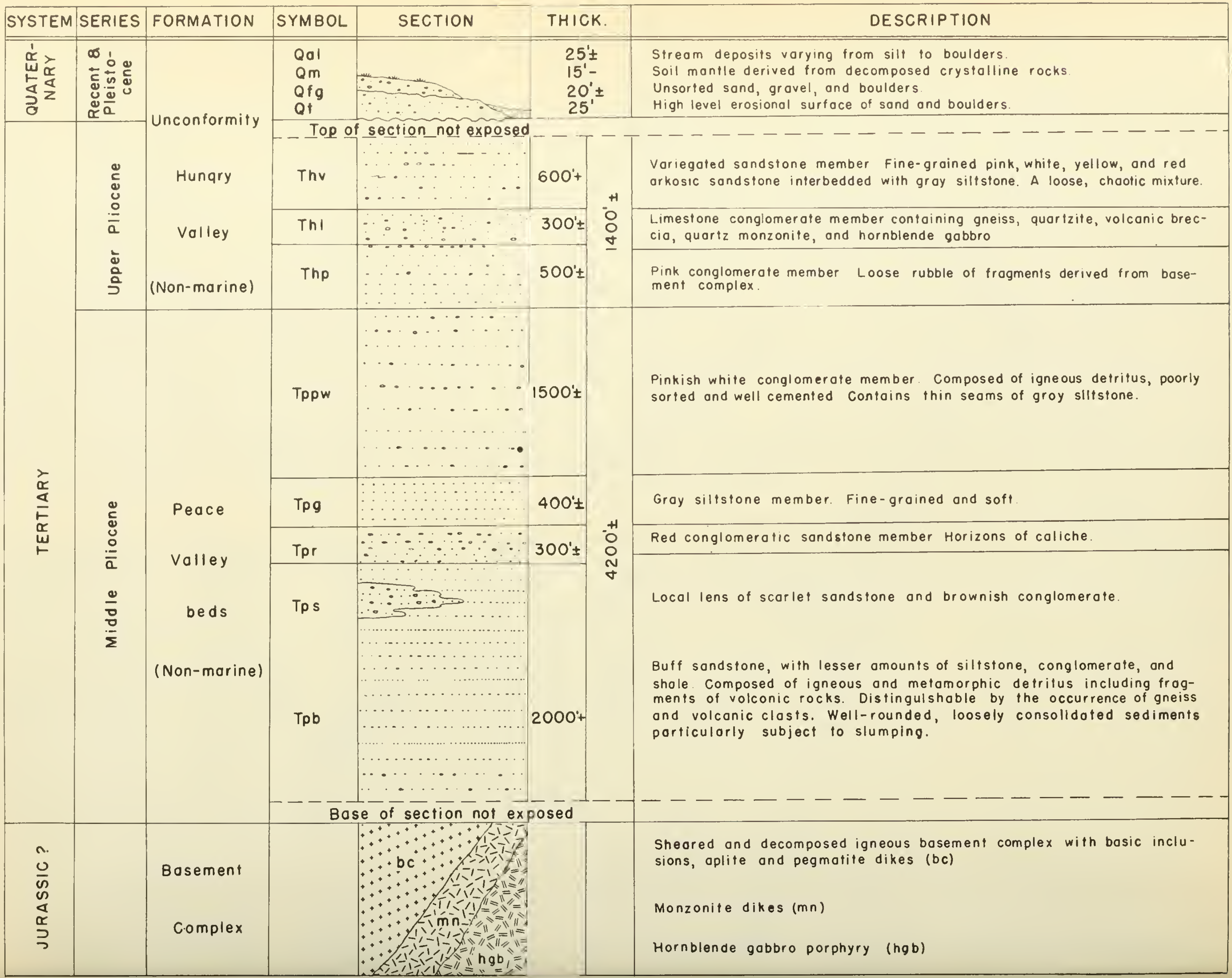
As seen under the microscope, the rock is estimated to have the following composition:

| | *Percent* |
|---|---|
| Plagioclase (oligoclase-andesine) | 35 |
| Potash feldspar (microcline and orthoclase) | 30 |
| Quartz | 20 |
| Biotite | 15 |
| Sphene, apatite, myrmekite, magnetite, zircon, saussurite, chlorite, hematite | Trace |

Commonly found within the quartz monzonite are dark elongate inclusions which range from a fraction of an inch to 10 or 20 feet in length. Their contact with the quartz monzonite is sharp and their dark appearance makes them conspicuous within an otherwise light-colored rock. The inclusions are composed primarily of biotite with lesser amounts of plagioclase, quartz, hornblende, and accessory minerals, especially sphene. These basic inclusions may represent either partially assimilated masses of the country rock into which the quartz monzonite was emplaced, or segregations of earlier crystallized minerals formed during the molten phase.

In addition to the basic inclusions, aplite and pegmatite dikes are quite common in the quartz monzonite and also throughout much of the crystalline basement complex. The dikes range from a few inches to over a foot in thickness and may extend for as much as 100 feet in length. Owing to the predominance of pink potash feldspar, the dikes invariably have a pinkish hue. Quartz, plagioclase, and biotite or muscovite make up the remaining constituents.

The various aplite and pegmatite dikes probably represent late stage products of a cooling magma which en-



| SYSTEM | SERIES | FORMATION | SYMBOL | SECTION | THICK. | | DESCRIPTION |
|---|---|---|---|---|---|---|---|
| QUATERNARY | Recent & Pleistocene | Unconformity | Qal<br>Qm<br>Qfg<br>Qt | | 25'±<br>15'-<br>20'±<br>25' | | Stream deposits varying from silt to boulders.<br>Soil mantle derived from decomposed crystalline rocks.<br>Unsorted sand, gravel, and boulders.<br>High level erosional surface of sand and boulders. |
| | | | Top of section not exposed | | | | |
| TERTIARY | Upper Pliocene | Hungry Valley (Non-marine) | Thv | | 600'+ | 1400'± | Variegated sandstone member Fine-grained pink, white, yellow, and red arkosic sandstone interbedded with gray siltstone. A loose, chaotic mixture. |
| | | | Thl | | 300'± | | Limestone conglomerate member containing gneiss, quartzite, volcanic breccia, quartz monzonite, and hornblende gabbro |
| | | | Thp | | 500'± | | Pink conglomerate member Loose rubble of fragments derived from basement complex. |
| | Middle Pliocene | Peace Valley beds (Non-marine) | Tppw | | 1500'± | 4200'± | Pinkish white conglomerate member. Composed of igneous detritus, poorly sorted and well cemented Contains thin seams of gray siltstone. |
| | | | Tpg | | 400'± | | Gray siltstone member. Fine-grained and soft. |
| | | | Tpr | | 300'± | | Red conglomeratic sandstone member Horizons of caliche. |
| | | | Tps | | | | Local lens of scarlet sandstone and brownish conglomerate. |
| | | | Tpb | | 2000'+ | | Buff sandstone, with lesser amounts of siltstone, conglomerate, and shale. Composed of igneous and metamorphic detritus including fragments of volcanic rocks. Distinguishable by the occurrence of gneiss and volcanic clasts. Well-rounded, loosely consolidated sediments particularly subject to slumping. |
| | | | Base of section not exposed | | | | |
| JURASSIC ? | | Basement Complex | | bc<br>mn<br>hgb | | | Sheared and decomposed igneous basement complex with basic inclusions, aplite and pegmatite dikes (bc)<br>Monzonite dikes (mn)<br>Hornblende gabbro porphyry (hgb) |

Figure 2.—Columnar section.

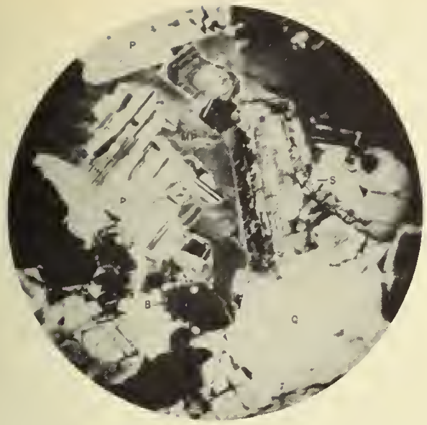
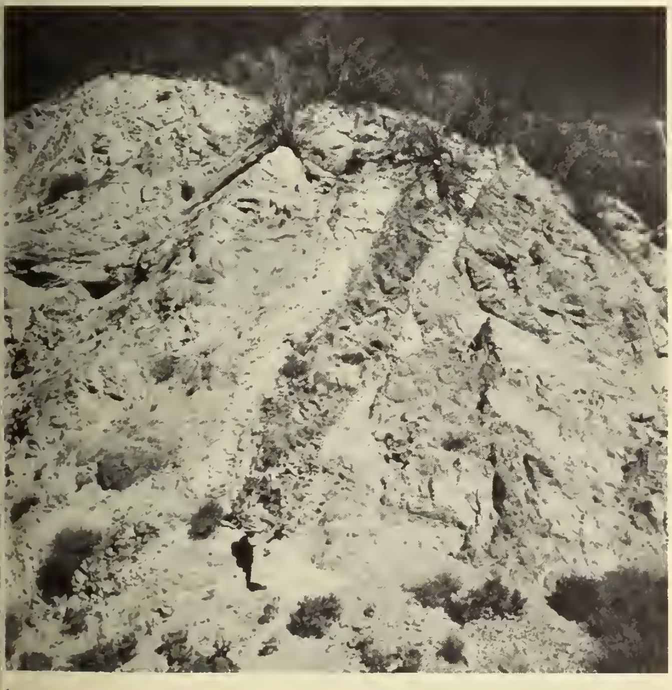


**Figure 3.** Photomicrograph of quartz monzonite. P, plagioclase; MP, microperthite; Q, quartz; S, sphene; B, biotite. Magnification 10x. Crossed nicols.

ered fractures in previously consolidated country rock. everal prospect pits have explored the intrusions, but o ore deposits are known to be associated with these ocks.

A fine example of a triple composite dike is exposed in roadcut along the Old Ridge Route about a mile south f Sandberg. The origin of such a composite intrusion is enerally explained by two magmas of different composiion being injected into the same channel. In the example ound in the Quail area a basic magma (dark-appearing uartz diorite) was first injected into a channel followed y the intrusion of an acidic magma (light-colored granite plite) along planes of weakness parallel to the dike walls. ome of this acidic magma which solidified into aplite n the margins was also forced into fissures in the interior f the basic dike thereby developing a network of aplite einlets.



**IGURE 4.** Triple composite dike in decomposed quartz monzonite. Old Ridge Route road cut.

*Granite.* Another rock occurring commonly in the Liebre Mountain complex is a light-colored granite. Its outcrop is irregular and it has no mappable boundaries. The granite breaks down so readily that unweathered outcrops are scarce. Like the quartz monzonite, the rock is highly sheared and aided by an irregular joint system, weathers into sub-spheroidal blocks. The granite is commonly porphyritic with phenocrysts of pink microcline and microperthite as much as one inch in diameter embedded in a medium-grained groundmass. In hand specimens other prominent minerals are quartz, plagioclase, and muscovite. Microscopic examination shows the plagioclase to be oligoclase ($An_{27}$). Biotite, the only dark constituent, occurs only in traces, while muscovite is the common mica in this rock. Small rounded grains of red garnet are conspicuous in the hand specimen. The relative amounts of the constituent minerals are estimated as follows:

| | *Percent* |
|---|---|
| Potash feldspar | 60 |
| Plagioclase | 20 |
| Quartz | 15 |
| Muscovite | 5 |
| Biotite, garnet, epidote, chlorite, sphene, pyrite | Trace |

Despite the highly sheared nature of the rock, the microscope does not reveal any marked cataclasis, other than undulatory extinction in the quartz, and an incipient mortar structure.

*Quartz Diorite.* In scattered outcrops within the basement complex a bluish gray medium- to fine-grained quartz diorite occurs. The rock has a hypantomorphic granular texture and no discernible foliation. Viewed under the microscope, a mild cataclastic texture appears to be superimposed upon the finer-grained granitic texture.

A representative specimen of the quartz diorite has the following estimated composition:

| | *Percent* |
|---|---|
| Plagioclase (andesine) | 65 |
| Quartz | 20 |
| Biotite | 10 |
| Hornblende | 5 |
| Sphene, apatite, chlorite, epidote, magnetite | Trace |

The white crystals of andesine appear as conspicuous equant grains in a dark gray groundmass. The grains show zoning from about $An_{30}$ to $An_{40}$. Biotite and hornblende are abundant and both display strong pleochroism. Within the larger biotite flakes crystals of sphene and apatite are conspicuous.

*Hornblende Gabbro.* Although in general the Liebre Mountain massif cannot be subdivided into separate facies, in the northwestern part of the area near the Liebre fault there is a dark rock which can be delineated. This is a hornblende gabbro, with hornblende making up at least 80 percent of the rock. Slightly zoned labradorite comprises about 15 percent of the rock, and biotite 5 percent. Traces of sphene, zircon, orthoclase, epidote, apatite, sericite, quartz, and hematite pseudomorphic after pyrite are common. Two varieties of the hornblende gabbro are present—one coarse-grained and the other medium-grained. The coarse-grained variety is by far the more common and comprises at least 80 percent of the gabbro. They are mineralogically similar although the medium-grained facies commonly contains a somewhat larger percentage of biotite. The hornblende occurs as shiny black elongate prisms which attain a length of three inches in the coarse-grained facies. Locally the grains are oriented, giving rise to a linear flow structure. The biotite is always strongly pleochroic from pale brown to light green to greenish blue. It occurs as small plates included in the labradorite, and some flakes contain euhedral grains of zircon surrounded by pleochroic halos.

*Monzonite.* A short distance east of the hornblende gabbro outcrop, but also near the Liebre fault, there is another rock differing noticeably from those typical of the basement complex. The bright orange color of the main mass of this igneous body contrasts sharply with the country rock. The contacts of the intrusion are highly irregular and difficult to map accurately. Their nature suggests that the rock was emplaced as a dike which has since been broken by faulting.

The bright color of the rock is due to the presence of a large amount of orange potash feldspar. The texture is hypautomorphic granular and the rock is medium- to fine-grained. Both the potash feldspar and plagioclase are greatly altered facilitating the deep weathering of the rock and possibly causing the peculiar porous structure which the rock exhibits locally. On the other hand, the well-terminated epidote and feldspar crystals which commonly extend into these small cavities suggest that the porous structure is a primary feature formed at the time of crystallization of the rock mass.

Viewed microscopically, the rock is seen to contain approximately equal amounts of plagioclase and orthoclase. The slightly zoned plagioclase is highly sodic for this type of rock as it lies in the albite-oligoclase range. The orthoclase is intergrown with sodic feldspar giving it a microperthitic texture. The albite twinning of many of the elongate grains of plagioclase appears bent or curved at the extremities of the crystals indicating mild cataclasis. Besides the plagioclase and orthoclase, epidote and chlorite are prominent constituents and comprise about 10 to 15 percent of the rock. In the examination of four thin sections not more than a trace of quartz was observed. The average composition of the rock was estimated to be as follows:

| | *Percent* |
|---|---|
| Orthoclase | 45 |
| Plagioclase | 40 |
| Epidote | 10-15 |
| Chlorite | 1-5 |
| Clinozoisite, sphene | Trace |

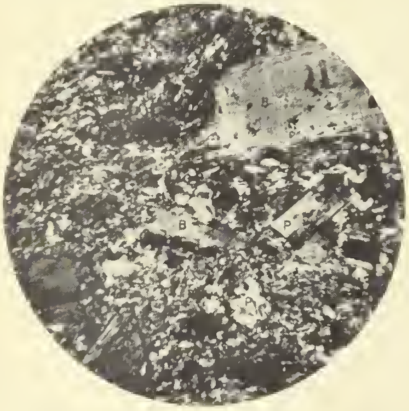


FIGURE 5. Photomicrograph of porphyritic andesite showing crude linear orientation of biotite; end of the large biotite flake in NE quadrant is drawn out and frayed. Magnification 25x. Crossed nicols.

### Volcanic Rocks

*Andesite.* Near the southern boundary of the are close to the Liebre fault a small exposure of porphyriti andesite occurs. The outcrop does not exceed 50 squar yards and similar rocks are found nowhere else withi the area mapped.

The rock has a dark gray aphanitic groundmass an contains phenocrysts of white plagioclase. With the ai of hand lens numerous flecks of biotite are visible. In thi section the rock is seen to be holocrystalline and is est mated to be of the following composition:

| | *Percent* |
|---|---|
| Plagioclase (andesine-oligoclase) | 59 |
| Biotite | 1 |
| Microcrystalline groundmass | 40 |
| Apatite, sphene, magnetite, quartz, chlorite, clinozoisite, epidote, myrmekite | Trace |

Some of the plagioclase is distinctly zoned and fal within the andesine-oligoclase range. The groundma between the phenocrysts contains a second generation tiny plagioclase crystals which are typically lath-shape and wholly unoriented forming a felty microlitic textur The biotite flakes are generally elongated and arrange with a crude linear orientation whereas the ends of t flakes are frequently drawn out and frayed suggesti that the rock has undergone slight metamorphism.

The determination of the relative age of the andesi is difficult because the rock occurs wholly within a bo of crystalline basement rocks. The appearance of t contacts surrounding the outcrop offers no conclusi evidence as to how the rock was emplaced. It may ha been emplaced via a subsidiary fracture related to t Liebre fault, and hence be post-Ridge Basin in age, it may have originated prior to the emplacement of t ancient Liebre Mountain-Redrock Mountain bathol and represents an isolated remnant of a pre-Jurassic v canic flow. The semblance of a metamorphic texture the andesite suggests the latter as the more likely ag

Some of the rock types in an assorted suite of volcan pebbles obtained from the Peace Valley beds are simil to this andesite. If these fragments were partly deriv from the andesite, its age is probably pre-Pliocene, i. the andesite originated previous to the deposition of t Peace Valley beds.

The closest known occurrence of volcanic rocks to tho in the area mapped is approximately 3 miles nort east, in the Neenach quadrangle, where they lie on t north side of the San Andreas fault (Wiese, 1950, 30-32). These volcanic rocks, consisting of andesite flo and tuff beds, are dubiously assigned to the Miocene Wiese. Crowell (1952) describes purple andesite lyi within the San Andreas fault zone north of the Qu andesite. Crowell (1950, p. 1631) also describes sm rhyolite plugs and obsidian occurring near Frazi Mountain about 14 miles to the northwest. The age the rocks at the last two localities is unknown and althou the rocks have been placed in the Miocene (?), it is a mitted that they may just as well be older or young ne of these rocks closely resemble the porphyritic an- site found in the Quail area and no conclusive evidence stifying correlation has been discovered.

### Tertiary Sedimentary Rocks

The Tertiary sedimentary rocks exposed in the area e estimated to be approximately 4500 feet thick and e wholly non-marine in origin. They are part of the quence called the Ridge Route formation by Clements (937), Ridge Basin series by Eaton (1939), and Ridge sin group by Axelrod (1950).

#### ace Valley Beds (Middle Pliocene)

The Peace Valley beds have the largest areal extent any of the exposed sedimentary units. The type area f them described by Crowell (1950) is in Peace Valley, mile to the west of the area mapped along Highway 99. owell did not give full formational status to the rocks cause the base of the unit lies south of the area he pped.

The Peace Valley beds in the Quail area may be con- niently subdivided into fine- and coarse-grained facies. e members comprising the fine-grained facies are aracterized by siltstone and fine sandstone. Conglom- ate beds are present in a few localities, but form a small action only of these members. Toward the north and rtheast the sediments increase in coarseness and grade o the coarse-grained facies. Its members are found the flanks of Liebre Mountain and are composed almost lusively of conglomerate and sandstone derived from Liebre Mountain massif.

*ine-Grained Facies.* The buff sandstone member of Peace Valley beds covers the greatest surface area any of the sedimentary members mapped. It extends gonally across the area roughly parallel to the strike the Liebre fault. The upper boundary is marked by appearance of fragments of gneiss and volcanic rocks ich constitute a rather large percentage of the coarser ction of the rock. Near the top the member is partly glomeratic but the unit rapidly becomes finer-grained er in the section. The base of this member is not ex- sed within the area studied but the portion of the sec- n found in the Quail area is probably 2000 feet thick. mps and landslides in loose siltstone are common, buff sandstone ridges stand out and permit the de- opment of vertical cliffs.

The sediments are dominantly buff to greenish-gray aracterized by a predominance of fine sandstone and dy siltstone with only minor amounts of conglomerate l shale. The approximately relative amount of the ponents in this unit is:

| | Percent |
|---|---|
| andstone | 60 |
| iltstone | 30 |
| onglomerate | 5 |
| hale | 5 |

The beds are generally massive although locally fine- ined sandstone is bedded in alternating light and dark ds. Locally crossbedding on a grand scale and scour- l-fill channels are prominent. Peculiar cylindrical or "ne"-shaped calcareous concretions, abundant in local es, are scattered throughout the section. Pearly-shelled *odonta* and unornamented ostracods have been found wo sites (fossil localities X1 and X2).

Most of the siltstone contains sand and is poorly sorted. It is bedded in strata about 3 to 6 inches thick. Dirty brown gypsum chips are found embedded locally within the siltstone.

The conglomerate fraction is composed of pebbles and cobbles of quartz monzonite, gray biotite gneiss, volcanic rocks, and massive white quartz. The individual pebbles and cobbles are well rounded but poorly sorted and only crudely layered. Individual beds are highly irregular and lens out within a short distance along the strike.

The dark fissile shale which constitutes only a minor part of this member is well distributed throughout the strata but seldom occurs in lenses thicker than a few inches.

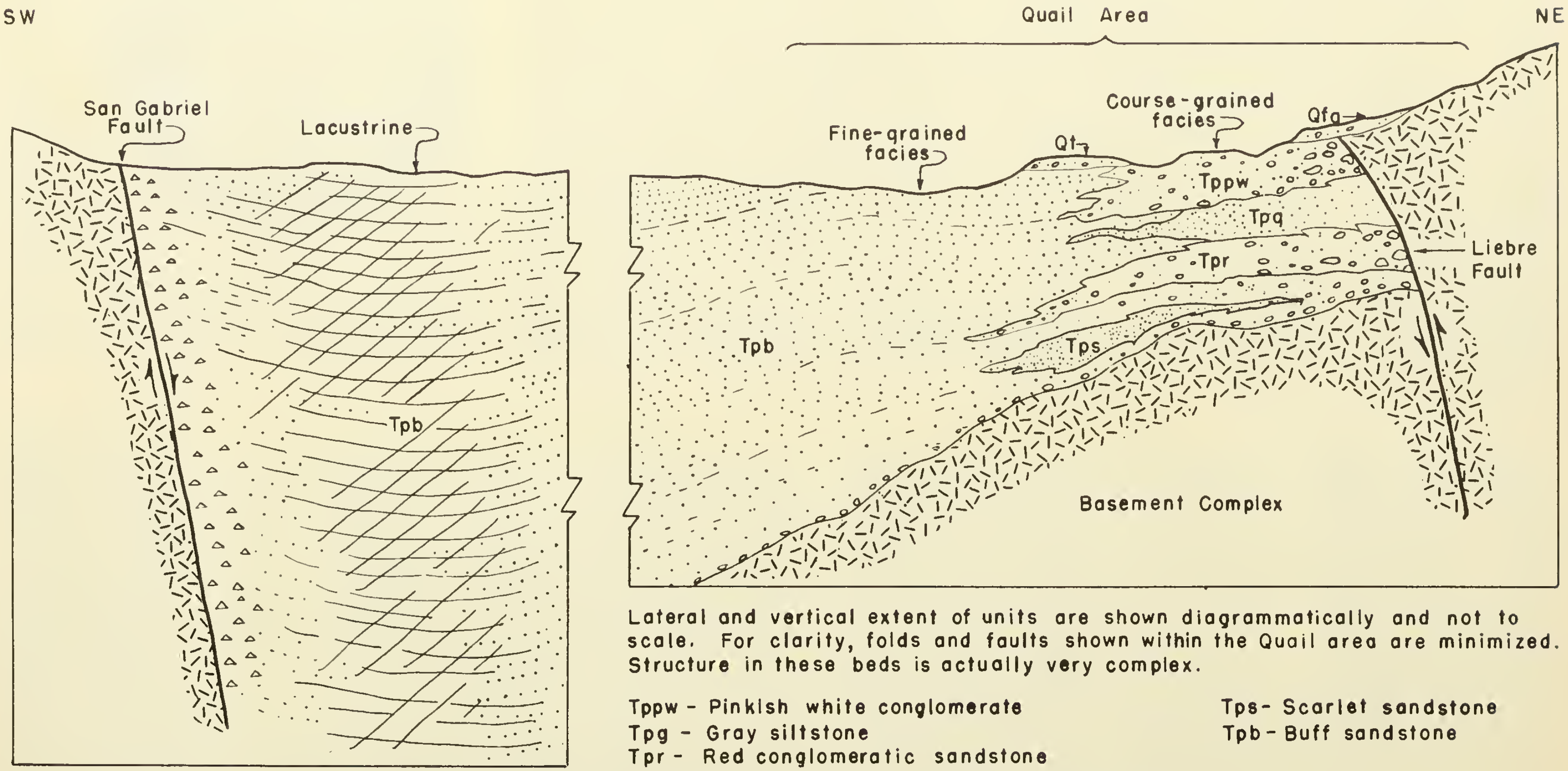
Resting against the lower branch of the Liebre fault in the southeastern corner of the area is a very bright red or scarlet sandstone unit. It weathers to a very soft soil of fine- to medium-grained constituents. Away from the fault the scarlet sandstone grades to a coarser chocolate-brown sandstone which contains zones of rounded concretions which are composed of tightly cemented fine gravel. The member is both overlain and underlain by sediments of the buff sandstone member described above and appears to be a lens within this larger sequence of rocks.

In the western part of the area a gray siltstone member interfingers with an overlying pinkish-white conglomerate member. Within the area studied, the base of the unit is severed by a fault, but drill cores from the Davidson No. 1 well in the northwestern corner of the area (sec. 26, T. 8 N., R. 18 W.) show that the gray siltstone lies stratigraphically above a red conglomeratic sandstone member. A study of the drill cores and ditch samples indicates that the thickness of the unit is approximately 400 feet.

The fine-grained siltstone is deeply weathered and appears as a powdery material mixed with tiny siltstone chips. The bedding in this member is obscure or totally lacking. A hard calcareous rock, partly replaced by siliceous material appears as mappable beds within the gray siltstone west of Davidson's Ranch. An unidentifiable fossilized vertebrate fragment was found in these beds (fossil locality X3).

*Coarse-Grained Facies.* A red conglomeratic sandstone member is bounded both above and below by nearly vertical faults, hence its thickness cannot be determined. In the northern part of the area, however, the thickness as indicated by cores from the Davidson Well is approximately 300 feet. This member differs from the adjacent pinkish-white conglomerate by its characteristic reddish color, higher percentage of sandstone, and smaller amounts of conglomerate. The clasts are well rounded to subangular and are poorly sorted. They consist entirely of crystalline rocks of the Liebre Mountain massif, especially those rocks of the massif which contain a large percentage of pink potash feldspar. The distinctive color of the member is due to the large amount of red sandstone which comprises the matrix. In the east the rocks are well cemented and very hard, but westward the unit becomes more friable and soft brown siltstone is interbedded with it.

In certain zones within the section the cobbles and pebbles are covered with concentrically banded fresh-



Lateral and vertical extent of units are shown diagrammatically and not to scale. For clarity, folds and faults shown within the Quail area are minimized. Structure in these beds is actually very complex.

Tppw - Pinkish white conglomerate
Tpg - Gray siltstone
Tpr - Red conglomeratic sandstone
Tps - Scarlet sandstone
Tpb - Buff sandstone

FIGURE 6. Diagrammatic section across northern part of the Ridge Basin showing facies changes in the Peace Valley beds and their relationship to the main basin of deposition.

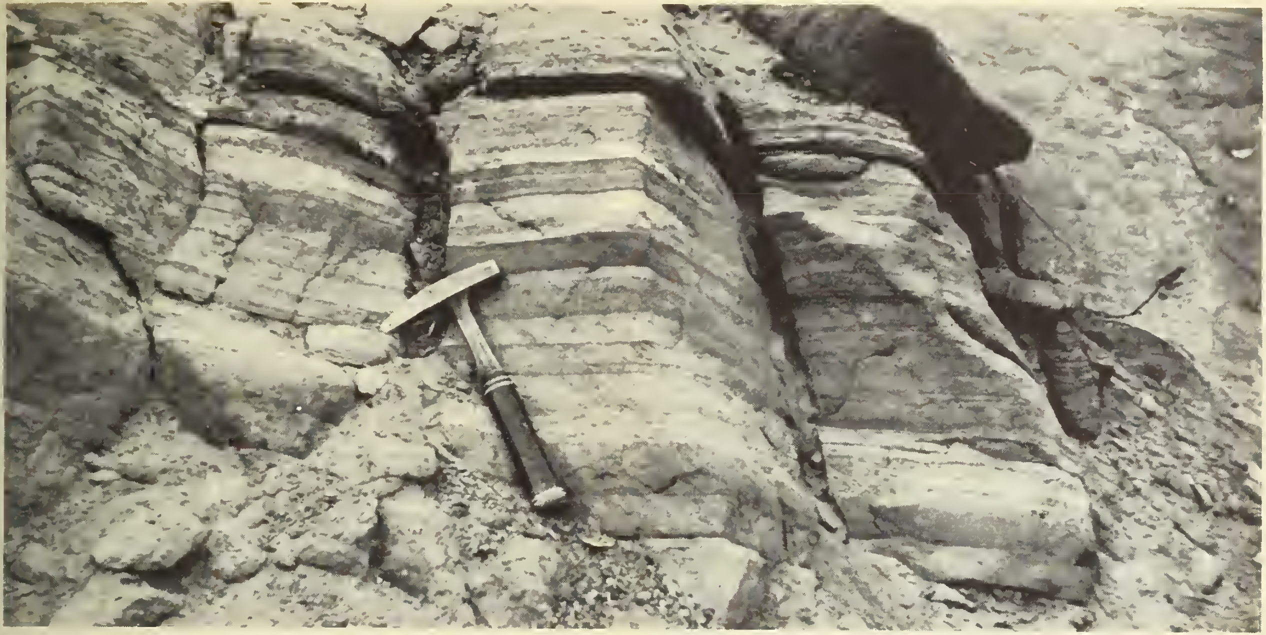
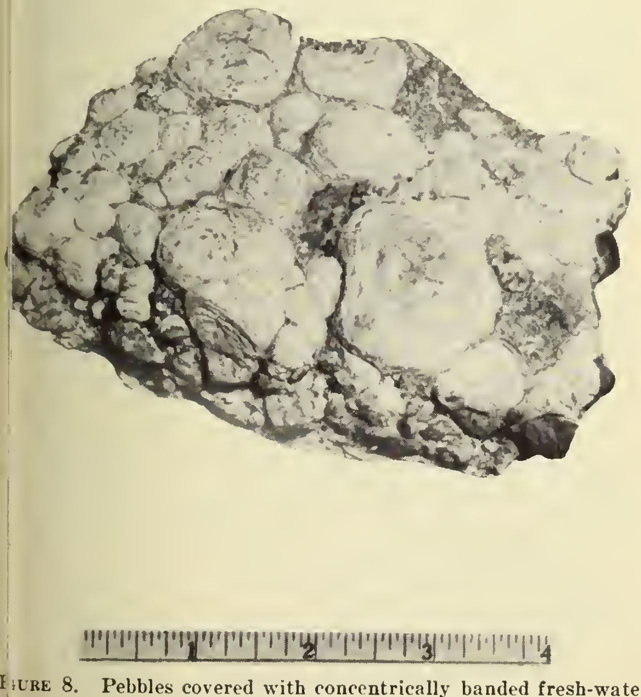


Figure 7. Thinly bedded buff sandstone in the Peace Valley beds. Road cut in Liebre Gulch.

vter limestone. The lime-carbonate layers are invariably frmed around a pebble or cobble serving as a central rcleus. By examination of thin sections no positive edence of cellular structure was found. However, under hgh magnification, the presence of circular blebs filled vth secondary calcite was seen, which might be a relict sucture of organic cells which has been largely destroyed o obscured by recrystallization. Unfortunately the evidnce at hand is insufficient to determine with certainty vether these lime-carbonate incrustations are of organic o inorganic origin.



Fure 8. Pebbles covered with concentrically banded fresh-water liestone. Occurs in red conglomeratic sandstone member in eastern part of the area.

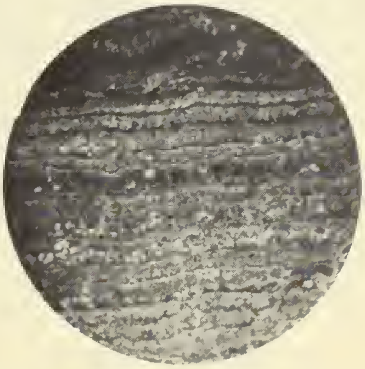


Figure 9. Photomicrograph of banded fresh-water limestone which develops as a crust on cobbles. Light circular blebs are filled with secondary calcite. Magnification 10x. Plain light.

The upper boundary of the pinkish-white conglomerate member is not exposed for it is truncated by the Liebre fault on the northeast. The bottom grades abruptly into or interfingers locally with the underlying gray siltstone member. Because of the structural complexities no accurate measure of the thickness can be made. It is estimated, however, that at least 1500 feet occur within the confines of the Quail area.

This unit is typically pinkish-white and is composed predominantly of rounded to subangular pebbles and cobbles of biotite quartz monzonite. These rocks contain a large percentage of pink potash feldspar which imparts the characteristic color to the member. The remaining part of the unit is made up of subordinate amounts of gray and white granite. The rocks closest to the Liebre fault are poorly sorted and include rounded boulders as much as 3 feet in diameter. Away from the fault most of the rocks show better sorting and the section becomes well-bedded.

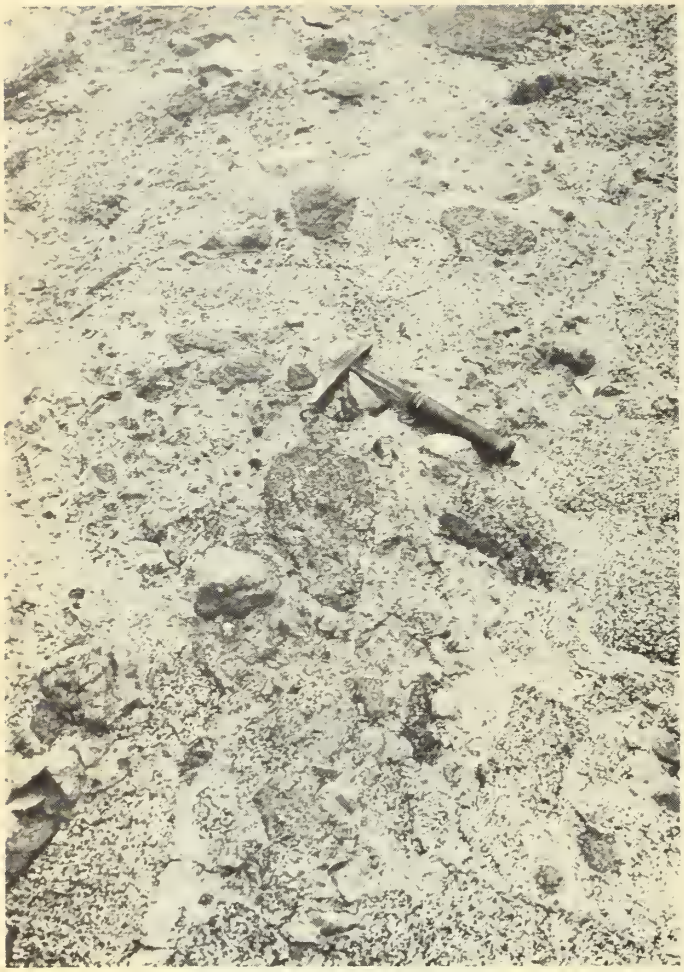


FIGURE 10. Pinkish-white conglomerate member in the Peace Valley beds. Exposed in Old Ridge Route road cut.

### Hungry Valley Formation (Upper Pliocene)

Some 1400 feet of continental sandstone, siltstones, and conglomerates of the Hungry Valley formation are exposed in the northwestern corner of the area. They differ from the underlying Peace Valley beds by their loose and massive appearance, and by the influx of clasts of limestone, quartzite, and volcanic rocks which are not found in the Peace Valley sequence. The type area of this formation is in Freeman Canyon, (Crowell, 1950, p. 1633), approximately 3 miles southwest of the area mapped. The Hungry Valley formation lies conformably on the Peace Valley beds outside the area mapped (see Crowell 1950). In the Quail area it is faulted against the Peace Valley beds and at the western end of Liebre Mountain the Hungry Valley sediments were deposited on the basement complex. The writer has subdivided the Hungry Valley sediments of the Quail area into three members which are described below.

Sediments of the pink conglomerate member form the basal beds of the Hungry Valley formation in the Quail area and lap across the quartz monzonite basement rocks. Within the area mapped, they also lie in fault contact with the gray siltstone member of the Peace Valley beds. This unit consists of about 500 feet of conglomerate made up essentially of debris from the basement complex. The sorting is very poor and bedding is almost indiscernible. The constituents are commonly angular and for the m part so poorly cemented that the outcrops consist of a lo rubble of pebbles, cobbles, and boulders.

Lying conformably upon the pink conglomerate memb is a 300-foot conglomerate composed of a great varie of rock types, but the presence of limestone boulde quartzite fragments, and volcanic breccia distinguis this member from all others in the area. The limesto conglomerate is loosely consolidated and contains su rounded to well-rounded boulders as much as 3 feet diameter. Among the rock types present are white crystallized limestone, pink and black aphanitic volca rocks, gray gneiss, pink quartz monzonite, hornblen gabbro, massive white quartz, and quartzite.

On the northwestern margin of the area is a variegat unit of fine-grained pink, white, yellow, and red sa stone interbedded with gray siltstone. These unconso dated sediments making up the variegated sandsto member, are subject to intense slumping which results a multi-colored, chaotic mixture of loose debris. Loca some cross-bedding is discernible and isolated zones c tain conglomerate composed of well-rounded pebbles. T composition of this member is predominantly arkosic. T top of the section is not exposed in the Quail area but it estimated that about 600 feet lies within the limits of t area mapped.

### Origin of the Peace Valley Beds and Hungry Valley Formatio

The sediments of the Quail area are a part of the nor eastern flank of the Ridge Basin syncline whose axis l 3 miles southwest of the area. This northwest-trendi structural trough lies between the Liebre Mountain Sawmill Mountain range on the northeast and the Pi Mountains * at the southwest. It averages some 7 mi in width and is about 20 miles long. From Liebre Mou tain southwestward, the sediments grade rapidly fr boulder conglomerate through coarse sandstone to silt a shale, indicating that the effective direction of transp tation was southwest. Working in the area to the we Creasey and Templeton (1939) also reached the concl sion that the drainage was toward the southwest by serving that volcanic pebbles in the sandstone near t axis of the trough are identical with those in the sedime in the east but are lacking in the sandstone on the weste shore.

The comparatively thin section of coarse sediments the east followed by the thick series of fine sandstone a silt suggests that the eastern area must have been a re tively low region topographically. Furthermore, the po degree of sorting, cross-bedding, and scour-and-fill cha nels are evidence of floodplain deposition. By a compa son of the fossil flora of the region with equivalent livi vegetation, Axelrod (1950) has also shown that t paleoecological setting at the time cf deposition was broad floodplain extending eastward from Ridge Bas lake with moderate hills at the present site of Liebrc a Redrock Mountains.

The composition of the cobbles in the coarse-grain facies of the Peace Valley beds clearly indicates that th members were derived from the igneous complex whi comprises Liebre Mountain. The plutonic fraction of t finer-grained facies can also be correlated with the Lie

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* Term applied to the mountainous region drained by Piru Creek a its tributaries. Axelrod (1950, p. 163).

Mntain massif. However, the location of the source area o the volcanic and gneissic fragments in this finer-gined unit is more difficult to explain. Presumably they ve derived from similar rocks between Liebre Mountain Redrock Mountain (Axelrod, 1950, p. 173, and Smith, 1, p. 25), but it is conceivable also that they might e been derived from remnants of an ancient (pre-assic?) country rock into which the Liebre Mountain-lrock Mountain batholith had been intruded.

he siltstone and shale units in the Peace Valley beds esent more quiet depositional conditions than those ting at the place of deposition of the coarse-grained es. The abundant biotite flakes and the arkosic nature f he rock suggests an environment where mechanical thering in a semi-arid climate dominated. That the ate during middle Pliocene time was semi-arid is con-ied by the paleobotanical studies of Axelrod (1950, p. 8).

he basal beds in the Hungry Valley formation lap oss the basement complex and bury the trace of the bre fault. This overlap relation began when movement the Liebre fault ceased and a northeastern extension f the drainage system developed permitting large unts of detrital material to be carried into the Ridge in.

he limestone conglomerate member which overlies the al sediments probably was derived from the highlands th of the Ridge Basin where expanses of granite are ciated with limestone roof pendants. The sediments e transported via the extended tributaries and on top f these rocks the finer-grained variegated sandstone nber was deposited. The "earthy" aspect of this unit s robably due to deposition after the highlands had been euced and the current of the tributaries was of insuf-ient strength to transport mud and silt beyond this t of the Ridge Basin.

### and Correlation of the Peace Valley Beds and gry Valley Formation

rom Gorman to 5 miles north of Castaic an unbroken ence of approximately 22,000 feet of sediments ords essentially continuous deposition from the end f Miocene into upper Pliocene time (Axelrod, 1950). se sediments make up one of the thickest sections of a Tertiary non-marine rocks known in North America. y rest unconformably upon sediments of similar lith-gy but of definite marine origin. These underlying ks contain both marine megafossils and marine fora-ifera representing late upper Miocene time (Loel, 7, p. 129).

aton (1939, pp. 538-544) subdivided the non-marine uence into four units, termed First Division, Second ision, Third Division, and Fourth Division. The rocks his Third and Fourth Divisions crop out in the area pped by the writer and correspond approximately to Peace Valley beds and Hungry Valley formation de-bed by Crowell (1950) in the Tejon Pass region.

*eace Valley Beds.* A few fresh-water fossils were ob-ied from fossil localities X1 and X2 on the Edison d in the southern part of the area. The fossils consist pearly shelled pelecypods and minute unornamented racods. The pelecypods were identified by Professor P. Popenoe as *Anodonta* sp. These fossils have little age significance but establish the rocks as being of fresh-water origin.

Near the top of the section, a fossilized vertebrate fragment was found in the hard calcareous beds within the gray siltstone member (fossil locality X3). Unfortunately, this bone fragment was not sufficiently well preserved to permit identification and additional material was not found.

At Piru Gorge, a point about 6 miles southwest of the area mapped, the fossil remains of a small fresh-water fish were described by L. R. David (1945) who considers the fish to be not older than middle Miocene and more likely Pliocene in age.

The age of the Peace Valley beds is established by their stratigraphic position in relation to a fossil flora found at Piru Gorge. Here a collection of fossil plants representing 23 different species was described by Axelrod (1950) who estimates their age to be middle Pliocene. As the Peace Valley beds lie stratigraphically above these rocks of known middle Pliocene age and below the upper Pliocene Hungry Valley formation, they also are assigned to the middle Pliocene. More recently, fossil plants found in the Peace Valley beds approximately 1.5 miles south of the Quail quadrangle have also been identified by Axelrod as middle Pliocene in age (in Smith, 1951, p. 24).

*Hungry Valley Formation.* No identifiable fossils were discovered in the Hungry Valley formation within the area mapped. However, about 4 miles southwest in a zone about 600 feet above the base of the formation, fossils consisting of fragments of horse teeth, and bones of camel, mastodon, and turtle were examined by Stock who reported that the fauna represents either late middle or early upper Pliocene time (in Crowell, 1950, p. 1638). Since 18,000 feet of conformable lower and middle Pliocene rocks lie below the fossil locality, and 3,500 feet of undated strata above, Crowell (1950) placed the Hungry Valley formation in the upper Pliocene.

### Quaternary Deposits

*Terraces.* Capping the highest hills south of Liebre Mountain are large flat terrace deposits composed of angular to subrounded pebbles, cobbles, and boulders. This material is unconsolidated and poorly bedded and its composition varies from place to place depending on the terrane from which it was derived. Frequently the terrace deposits can be distinguished from the Tertiary sediments by the fact that they are coarser grained and contain more boulders than the underlying sediments. Where they contain volcanic rocks or gneiss the terrace deposits also can be readily differentiated from those underlying Tertiary sediments which do not include such rock types.

*Fanglomerate.* Fanglomerate composed of reddish-brown detrital material derived from Liebre Mountain lies unconformably on Pliocene sediments immediately south of the Liebre fault. In the southeastern corner of the area, the fanglomerate is found resting directly on the crystalline basement complex. The Quaternary fans are recognized by their long flat surfaces extending conspicuously away from the crystalline highlands from which they were derived.

*Mantle.* The gentle rolling upland of the Liebre Mountain massif consists of a thick mantle of decomposed igneous rock. This soil mantle is well developed and

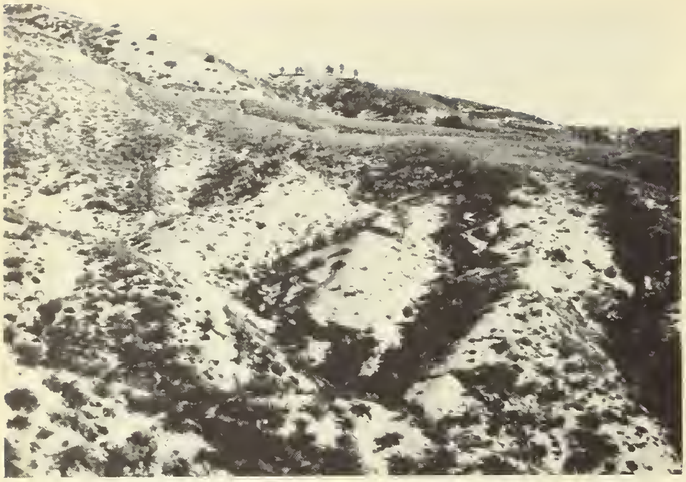

FIGURE 11. Fanglomerate capping eroded anticline. View southeast along axis of fold.

reaches a known depth of approximately 10 feet. In steep gullies on the crest of the mountain the base of the mantle is clearly exposed and grades upward from fresh crystalline rock through a more decomposed facies to a dark rich soil.

*Alluvium and Older Stream Conglomerate.* Alluvium, presumably of Recent age, was mapped along Liebre Gulch, West Fork Liebre Gulch, and at Davidson's Ranch. Narrow bands of alluvium, too small to be mapped, are also found along the many dry streams throughout the area. These unconsolidated sediments are a minor feature in the area for nowhere are they well developed or very thick.

In the upper reaches of Liebre Gulch, older stream conglomerate overlies the basement complex and is now exposed above the present stream channel in nearly flat attitudes. The constituents of these consolidated se- ments are rocks of the typical basement complex. Th represent deposits of an earlier stream which has be rejuvenated.

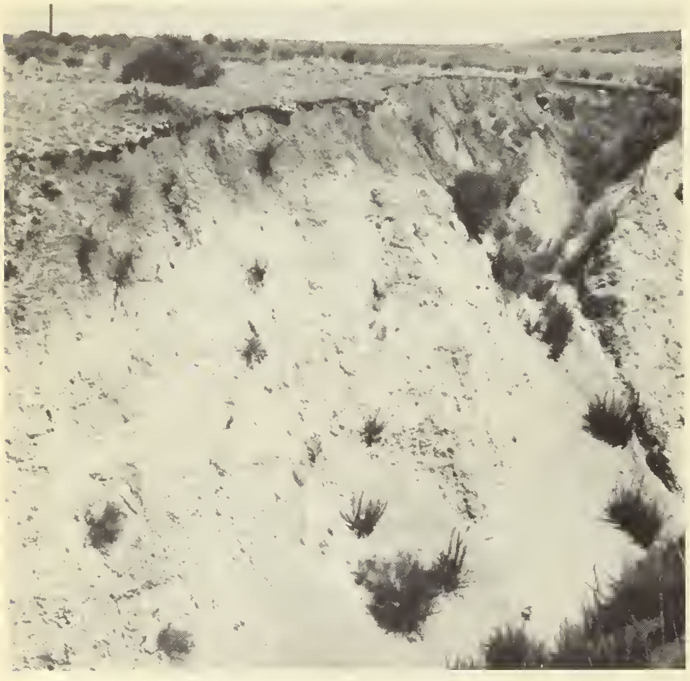

FIGURE 12. Soil mantle derived from the underlying partially decomposed crystalline rocks. Exposure near crest of Liebre Mountain.

## STRUCTURE

The mapped area of the Quail quadrangle is a part f the northeastern flank of the Ridge Basin syncline, a co- plex basin bounded by the San Andreas fault zone, t San Gabriel fault zone, and the Liebre and Clearwat faults. Because the symmetry of the syncline in the nort- ern part of the basin is disrupted by numerous tight fol, the structure of the area can more accurately be describ as part of the broad synclinorium which forms the nort- ern end of the Ridge Basin. Such complex folding is u- known in the basin southward. In addition to the ma small folds, the area is characterized by numerous fau both large and small. The most prominent of these s Liebre fault, a large high angle thrust which brir s crystalline rocks of the basement complex over the Pl- cene sediments.

Apparent simplicity in some parts of the geologic m may be due to lack of adequate exposures. Also in so areas road cuts and stream canyon exposures reveal lo l complex structures too small to be shown on the geolo map. It is hoped that these local exceptions do not aff t the over-all structural picture and that they can omitted without danger of oversimplification.

### Faults

*Liebre Fault.* The most important structural feat in the Quail area is the Liebre fault which was nam l and described by Eaton (1939, p. 550.)

The Liebre fault is recognized by the conspicuous c- tact it makes between the crystalline rocks to the nor - east and the Pliocene sediments on the southwest. T s prominent fault trace is exposed on the western side f Liebre Mountain and extends southeastward toward Sa- mill Mountain.

Toward the east, the fault dips at a low angle so t t its trace is very sinuous and approximates the topograp contours. Near the eastern margin of the area the Lie fault divides. Here a lower branch has split off a separ wedge of crystalline rocks from the principal part of e basement complex and has pushed it upward ahead of e main mass of the upthrust block of crystalline rocks. T s lower branch extends northwestward for about 2 mi s where it probably terminates against a transverse fa t in about the central part of the area.

Where the Liebre fault crosses the Old Ridge Route a narrow zone of breccia and slickensides is observed, t in the remaining part of the area the fault is knife-sha and such features are conspicuously lacking. The - thrust massif itself is broken by innumerable high- a l low-angle shears which cut the crystalline rocks into assortment of igneous rock types.

In the northwestern part of the area the Liebre fa t steepens so that its surface trace is much straighter - cept for two deep embayments where it is offset by tra - verse tear faults. At the northern end of the fault e trace disappears under sediments of the Hungry Val formation. Near this point another fault intersects e main Liebre fault at nearly right angles and brings to e surface a small sliver of the basement complex.

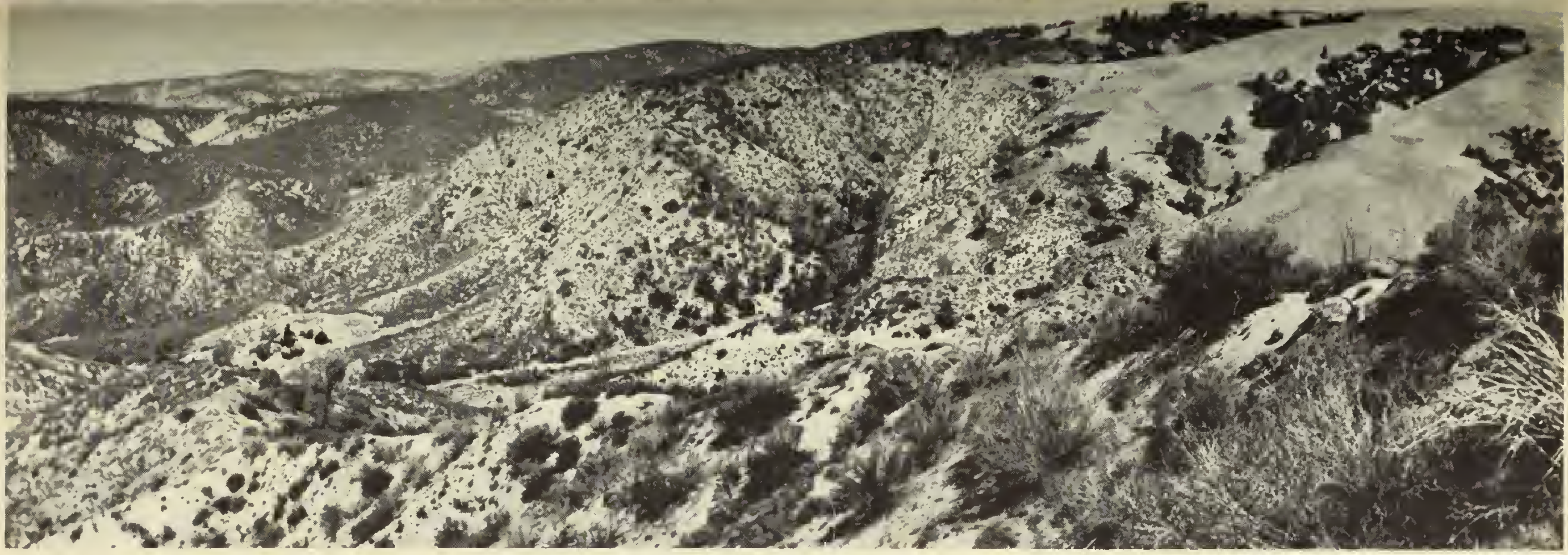

FIGURE 13. View northwest across Liebre Gulch. Liebre fault contact is delineated by sharp break in density of vegetation. The gentle rolling crest of Liebre Mountain is blanketed by a thick mantle of decomposed igneous rock.

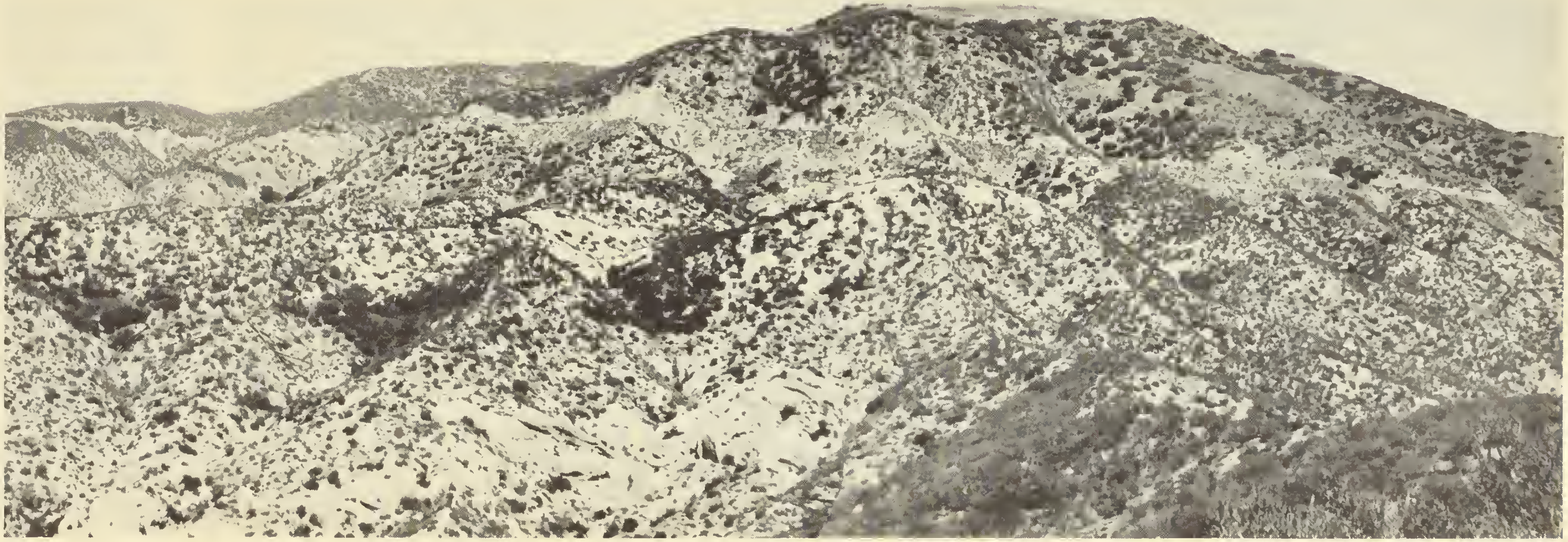

FIGURE 14. View east toward Old Ridge Route. Liebre Mountain crystalline rocks in background and northwest-trending Peace Valley beds in foreground. Fault is delineated by patches of dense vegetation at spring seepages. Prominent unit near bottom of picture is faulted syncline in red conglomeratic sandstone member.

The north side or hanging-wall of the Liebre fault is the upthrown block, as indicated by the fact that older rocks (Jurassic ?) of the hanging-wall block lie upon younger (Pliocene) sediments of the footwall.

If the hypothesis that movement along tear faults is generally parallel to the strike of the tear be accepted, then the presence of the two tear faults which intersect the Liebre fault at nearly right angles suggests that the displacement on the Liebre fault (at least in this locality) was wholly dip slip with no strike slip component. From this it follows that the direction of the thrust was from the northeast. The alignment of the folds in the Peace Valley beds which lie with their axes parallel to the northwest trending Liebre fault also suggests that the movement on the fault was at right angles to these folds, or in other words, from the northeast.

An estimate of the amount of vertical displacement on the Liebre fault can be had from well data obtained from the Davidson well. Drill cores from this well indicate that the drill reached decomposed granitic rock at about 1500 feet. Since the well site lies in a canyon bottom approximately 400 feet below the crest of Liebre Mountain, it can be estimated that the amount of throw on the fault is about 1900 feet.

Movement on the Liebre fault took place principally before late Pliocene time. This is indicated by the fact that in the northwestern part of the area Hungry Valley sediments of upper Pliocene age lap over the fault.

*Other Faults in the Peace Valley Beds.* The Peace Valley beds contain a rather complex fault pattern which is partly obscured by landsliding, poor exposures, and the general homogeneity of the rocks affected. Owing to the failure to find more than a few persistent recognizable lithologic units in the buff sandstone member, only a few faults within this extensive unit are shown on the geologic map.

On the geologic map a hypothetical fault has been shown along the West Fork Liebre Gulch. This fault is hidden beneath alluvium in the creek bottom. That such a fault exists is inferred from the anomalous attitudes in the strata adjacent to the canyon, and by the discontinuous nature of the fold axes on either side of the creek bottom. A similar situation occurs in Liebre Gulch. Here, however, the fault trace is visible in two places where the fault has deviated from the canyon bottom and has sheared across the strata on the banks of the creek.

Other faults within the Peace Valley beds include two semi-parallel faults which bound the red conglomeratic sandstone member and bring this unit to the surface. These faults separate sharply the bright red beds from the adjacent pinkish white conglomerate member. The surface traces of these faults are also marked by an alignment of numerous springs. The springs support a dense growth of vegetation which makes their location apparent even at a distance.

*Faults in the Hungry Valley Formation.* Two faults of unknown displacements are exposed in the Hungry Valley formation within the area mapped. One of these is a steep southeast-dipping reverse fault which abruptly terminates the outcrop of crystalline basement rocks on the north side of Liebre Mountain. Because this fault displaces upper Pliocene Hungry Valley sediments and terrace deposits it has apparently moved more recently than the Liebre fault (lying on the south side of Liebre Mountain) which cuts sediments no later than middle Pliocene. The other fault in the Hungry Valley formation displaces the variegated sandstone member downward to an unknown depth.

### Folds

The strata of the Peace Valley beds show an intense degree of tight folding and as many as 54 separate fold axes were mapped. The axes shown on plate 1 were selected to represent the trend of folds considered to be of more than local extent. It was impossible to show on the map those folds which are so tightly compressed that their axes are only separated by a few tens of feet. Also it was impossible to map those folds so doubled back upon themselves that at a single exposure they appear at different levels in the same vertical plane.

In general, the fold axes trend in a northwest direction and lie parallel to the trace of the Liebre fault. This parallelism is suggestive of a relationship between the orogenic forces which created the Liebre fault and those which caused the folds.

## GEOMORPHOLOGY

The steep-walled V-shaped canyons attest to a stage of youthfulness in the present geomorphic cycle. Evidence

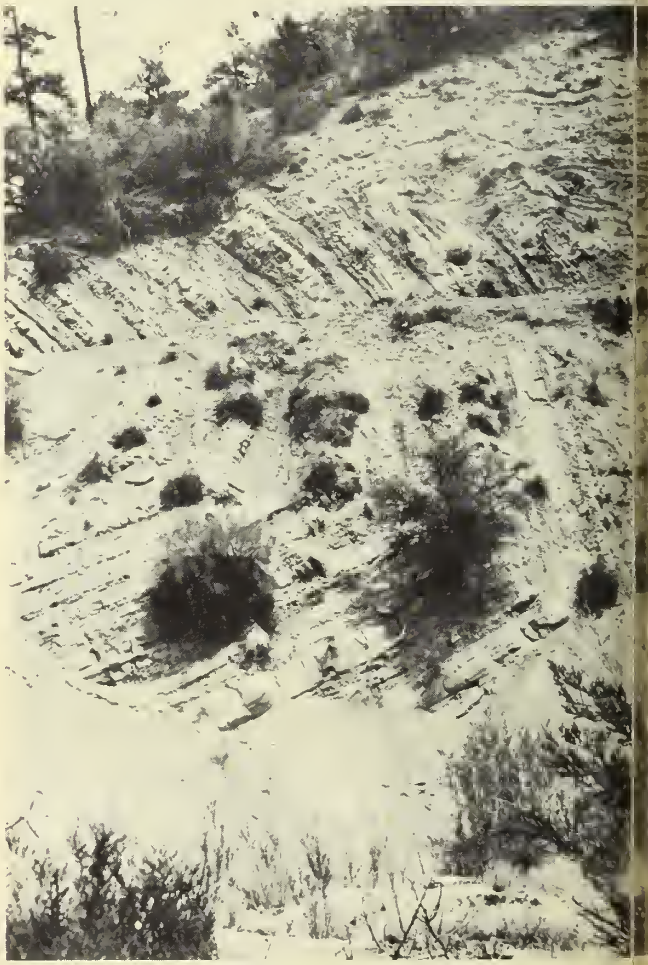

Figure 15. S-shaped fold in Peace Valley beds exposed in central part of Quail area. Edison road in upper part of view.

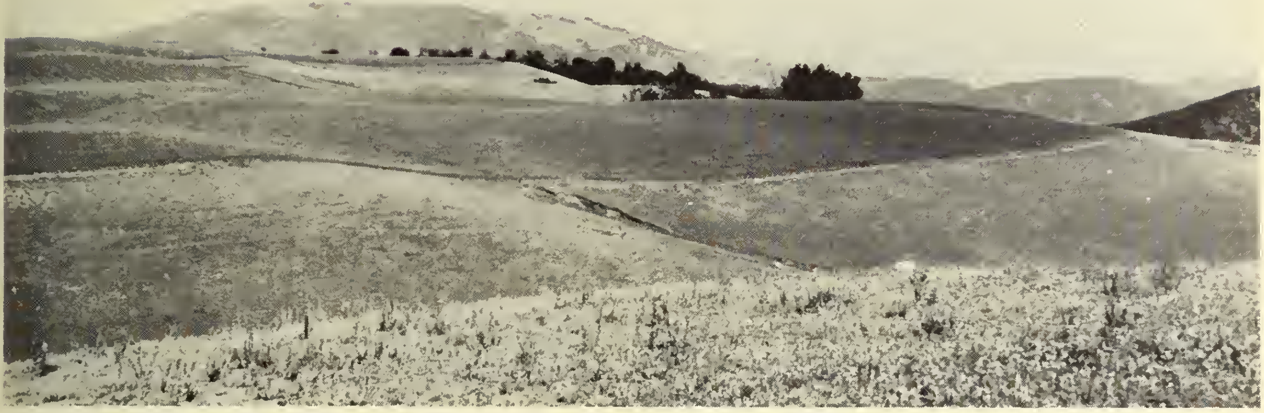

Figure 16. Gentle rolling crest of Liebre Mountain representing an older erosional surface.

at the area has passed through a previous geomorphic
cle which reached maturity is found in the flat ero-
onal surface which caps the highest hills. The relatively
cent uplift of the area has disrupted the stream equili-
rium and has resulted in the dissection of this high-level
rface. The presence of older stream conglomerates in
e elevated stream canyons, as for example in the upper
aches of Liebre Gulch, also attests to the recency of
plift.

The gentle rolling crest of Liebre Mountain stands in
arked contrast to the narrow canyons of steep gradient
lower levels. This undulating surface is suggestive of
older erosional surface which probably developed con-
mporaneously with the deposition of the Quaternary
rrace deposits lying west of Liebre Mountain. It is be-
eved that as the erosional surface was being developed
provided the sediments for the terraces. Since their
rmation in late Quaternary time, recent uplift has al-
wed the soft sediments to be deeply dissected. As a
sult, the Quaternary terraces have been intensely
odified by erosion and greatly diminished in areal ex-
nt. On the other hand, the crystalline rocks of Liebre
ountain, being harder than the sediments, erode more
owly and hence stand at a slightly higher elevation than
e terraces.

Although only a few small landslides or slumps are
dicated on the map a great many more are present in
e area. That most of these have moved in Recent time
indicated by gaping fissures and the askew position of
ees on the shifting ground. Other landslides are much
der and have been considerably modified by erosion but
ey can be easily recognized by their jumbled structure.

## ECONOMIC GEOLOGY

*Gold.* Colors of gold obtained by panning the gravels
the slopes of Liebre Mountain have been reported
iese, 1950, p. 45). Although the igneous rocks of the
ea have been prospected for numerous years, no min-
al deposits of economic value have been discovered.

*Petroleum.* Indications of petroleum in the Castaic area have encouraged leasing and exploratory drilling as far north as the Quail quadrangle. South of the Quail area (Redrock Mountain quadrangle) the Peace Valley beds lap over marine sandstones of Miocene age, indicating that these potentially petroliferous marine rocks may extend under the non-marine strata as far north as the southern part of the area studied. In this part of the Quail area there exists a thick section of porous and permeable reservoir rocks and the numerous folds could easily provide suitable traps. However, so far, no success has been obtained in locating marine source-rocks in this northern part of the Ridge Basin. Continental Oil Company's "Elbe—USL" No. 1 test well which was drilled late in the fall of 1951 a short distance southeast of the Quail quadrangle (in sec. 20, T. 7 N., R. 17 W.), passed directly into gneissic basement rock after penetrating about 4,450 feet of non-marine Ridge Basin-type sediments. Another well, the Pine Canyon Oil Company's "Davidson Well" No. 1 was drilled in 1948 near the northern boundary of the area (sec. 26, T. 8 N., R. 18 W.). This hole passed through coarse sandstone and hard conglomerate and probably bottomed in decomposed granite at 2700 feet. Detailed mapping now shows that the well was drilled on the north limb of a faulted anticline. The closest exploratory well to the Quail quadrangle within the Ridge Basin which has reported shows of oil and gas so far has been the Castaic Oil Company's "Mary Austin" No. 1. This well is located in sec. 28, T. 6 N., R. 17 W., which is one township south of the Quail quadrangle.

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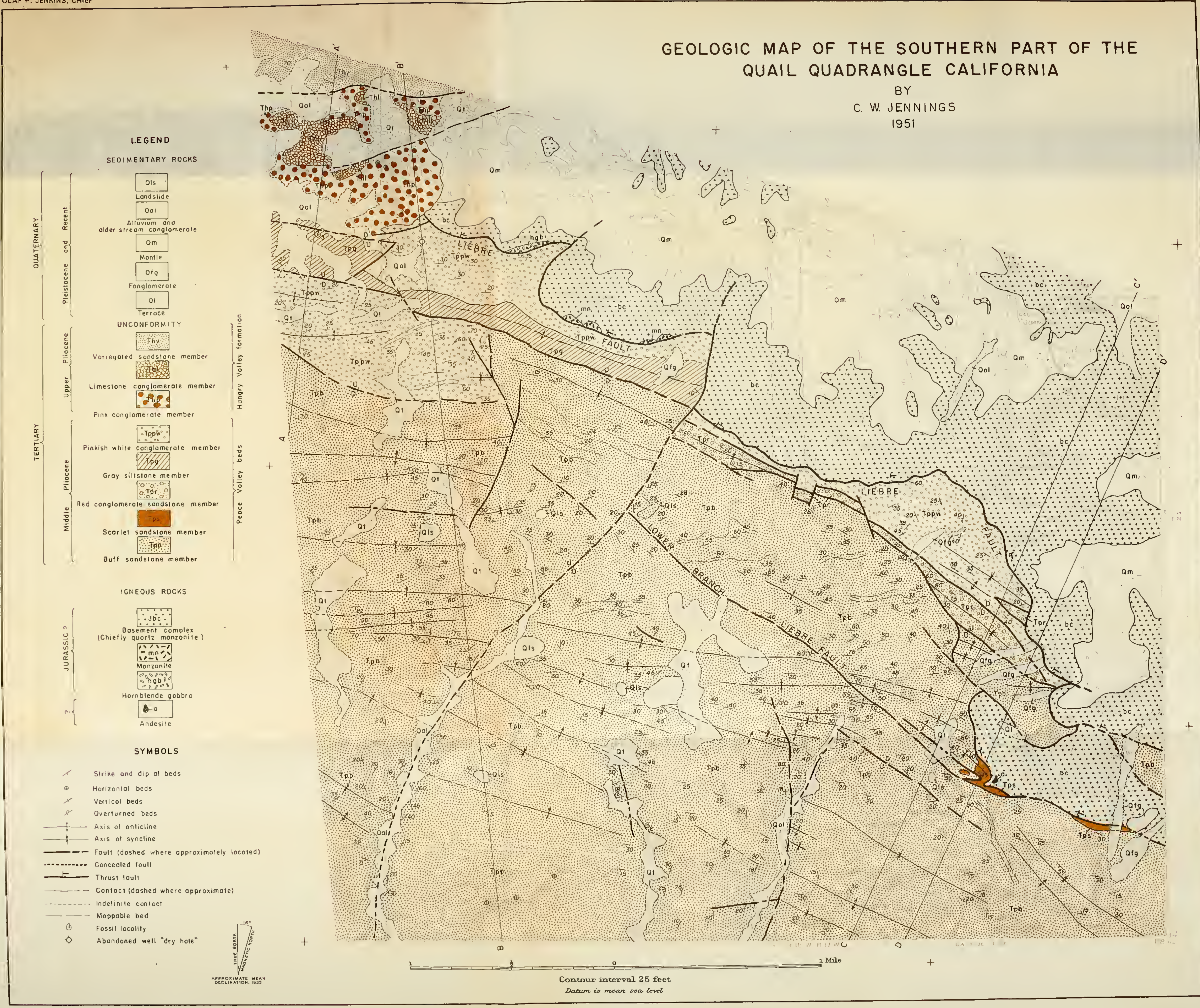
# GEOLOGIC MAP OF THE SOUTHERN PART OF THE QUAIL QUADRANGLE CALIFORNIA

BY

C. W. JENNINGS

1951



# GEOLOGIC SECTIONS ACROSS THE SOUTHERN PART OF THE QUAIL QUADRANGLE CALIFORNIA

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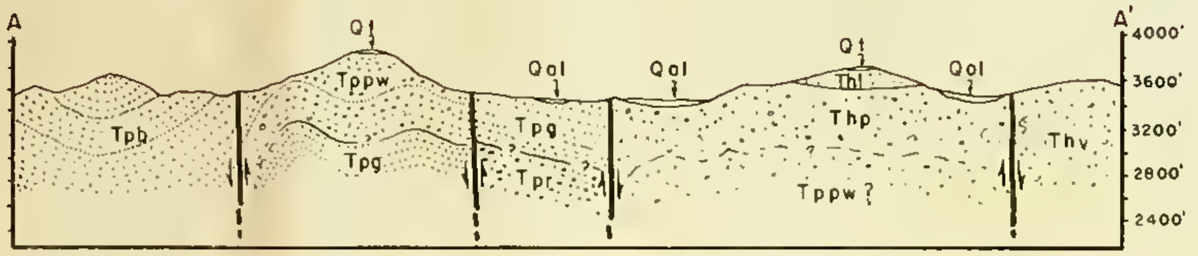
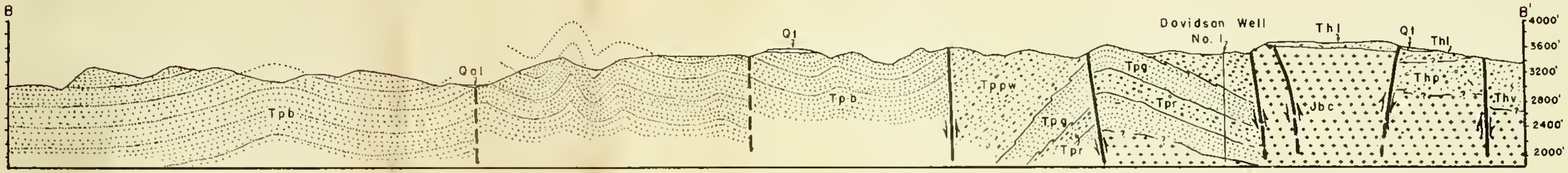
C.W. JENNINGS

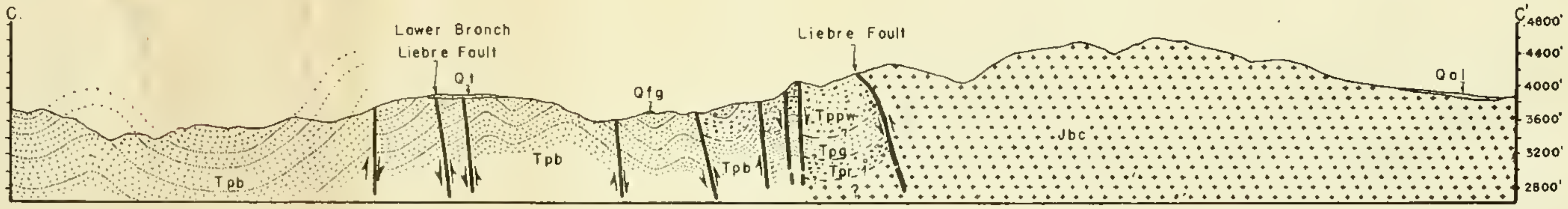
1951

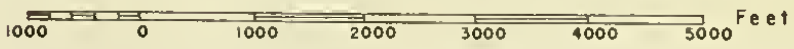




## LEGEND

| | | |
|---|---|---|
| *Quaternary Deposits* | Qal | Alluvium |
| | Qt | Terrace Deposits |
| | Qfg | Fanglomerate |
| | Qm | Mantle |
| *Pliocene Hungry Valley Formation* | Thv | Variegated sandstone |
| | Thl | Limestone conglomerate |
| | Thp | Pink conglomerate |
| *Pliocene Peace Valley Beds* | Tppw | Pinkish white conglomerate |
| | Tppg | Gray siltstone |
| | Tpr | Red conglomeratic sandstone |
| | Tps | Scarlet sandstone |
| | Tpb | Buff sandstone |
| *Jurassic (?) Plutonics* | bc | Basement complex (mostly quartz monzonite) |
| | hgb | " " Hornblende gabbro |
| | mn | " " Monzonite |
| *Volcanics Age Unknown* | a | Andesite |





HORIZONTAL AND VERTICAL SCALE